

Interface Definition Document between the Empty Long Life Battery Assembly and its Cell Module/Brick Assembly

Engineering Directorate
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Feb 2008



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PREFACE

The Interface Definition Document between the Long Life Battery (LLB) for the Extravehicular Mobility Unit (EMU) and its Cell Module and Cell Brick Assembly defines the mechanical, electrical, thermal, and environmental requirements of that interface. The top-level requirements flow down from the Project Technical Requirements Specifications, JSC 29929. This document will be configuration managed by the GFE EMU Battery Project Manager.

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 2/5/08

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NASA JSC/EP5

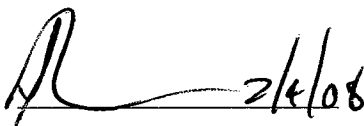
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Change Record

Rev.	Date	Originator	Concurrence	Approvals	Description
	February 2007	G. Varela	F. Davies	E. Darcy	Basic
A	Feb 2008	G. Varela	E. Darcy	S. Russell	Changed LIB to LLB throughout. Expanded the LLB redesign possibilities to include achieving it with one cell brick as equivalent to 5 cell modules. This is done throughout the document. Trimmed the acronyms list.

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1. INTRODUCTION

The purpose of this document is to define the requirements of the interface between the LLB Assembly and its Cell Module and Cell Brick Assembly to facilitate the sourcing of an alternate cell module or cell brick design to the original LIB Assembly (P/N EV032656-1) design by ElectroVaya Corp.

1.1 SCOPE

This document applies to Government Furnished Equipment (GFE) LLB Assembly for the EMU, whose basis is the LIB Assembly (P/N EV032656-1). As the LIB Assembly is being redesigned for a new cell module or cell brick, it will be renamed the Long Life Battery (LLB). The LIB Assembly encloses 5 cell modules connected in series. The LLB design can be achieved with new designs of either of two line replaceable units: 5 cell modules or 1 cell bricks. The only other allowable design change in converting from the LIB to the LLB design is the shape of the Interconnecting Printed Circuit Board.

1.2 RESPONSIBILITY AND CHANGE AUTHORITY

The responsibility for the development of this document lies with the Energy Systems Division.

2.0 APPLICABLE DOCUMENTS

The following documents of the exact issue shown where used in the generation of this specification to the extent specified herein. If date or revision number is not identified, use latest version.

Document Number	Revision / Release Date	Document Title
JSC-29929	Rev B/ draft	Project Technical Requirements Specification for the Long Life Battery GFE for the EMU
JSC-29928	Rev E	Long Life Battery (LLB) End Item Specification GFE for the EMU
JSC-29927	Rev N	Lithium-ion Battery (LIB) Charger End Item Specification GFE for the EMU
EV032656		LIB Assembly Drawing
EV032661		Cell Module Assembly Drawing
EV307705	RevF	Interface Definition Document for the LIB
ICD-4-0012-0C-1	RevB	ICD for the EMU-PLSS and its Battery

3. Mechanical Interfaces

3.1 Fit and Dimensional

The mechanical interface between the LIB Assembly and the Cell Module consists of 5 articles fitted in a custom box with a fastened lid. The housing of the LIB has tapered sides that match the one degree taper of the edges of the Cell Module (See Figures 1 and 6). The Cell Modules are immobilized in the housing by virtue of the lid edges contacting the top shoulders of the Cell Modules (See Figure 2). Overall dimensions of the Cell Module are in accordance with the drawings in Figures 3-5; minor dimensions and tolerances are omitted for clarity. The terminals of the Cell Module are at the top and are shown in Figure 5. Each terminal has two threaded blind holes sized for a No. 8 fastener (P/N NAS1101E08-4) and its self-locking helicoil insert (P/N MS21209-C0810). The negative terminal is visually differentiated from the positive with a machined dimple. The new cell module design would have to meet the fit and dimensional requirements described herein. Alternatively, the new cell brick design would have to meet the fit and dimensional requirements as a single block equivalent to 5 cell modules series.

3.2 Weight

The Cell Module weight shall not exceed 970 g. Alternatively, the Cell Brick weight shall not exceed 4850 g.

3.3 Reliability

The requirement of the LIB is to be two-failure tolerant to catastrophic failures and single-failure tolerant to critical failures. However, due to its simplicity of design and to the simplicity of the design of the PLSS interface, there is one deviation (low impedance failure) from this requirement, as listed in the Critical Items List for the LIB. The cell module must be capable of meeting this reliability requirement after any one high impedance failure. The current Cell Module design does not meet this because a single cell failure prevents meeting the capacity requirement.

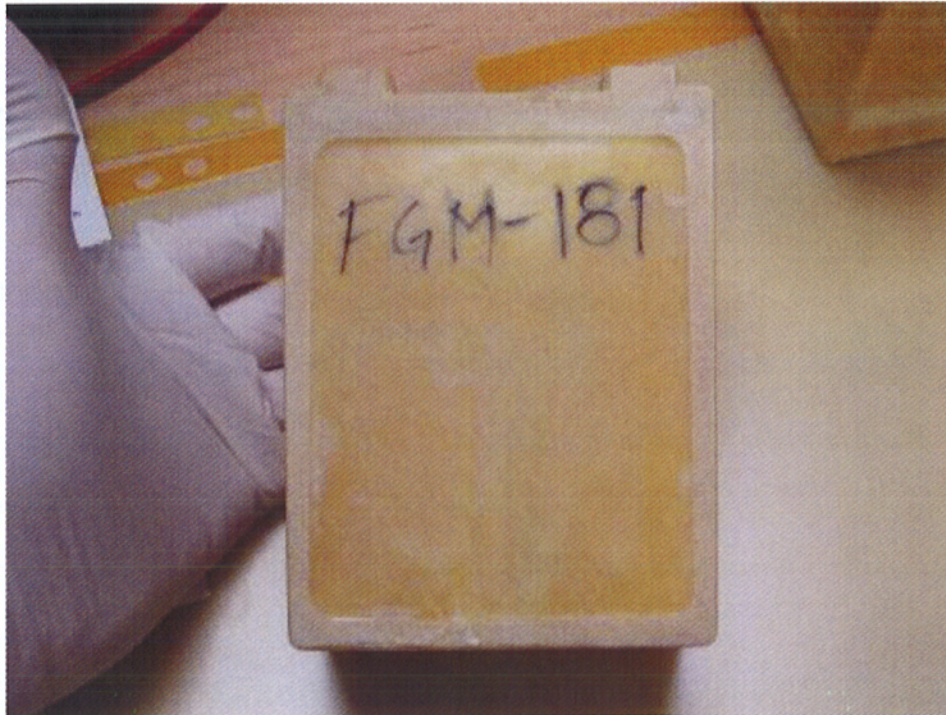


Figure 1. Side View of LIB Cell Module

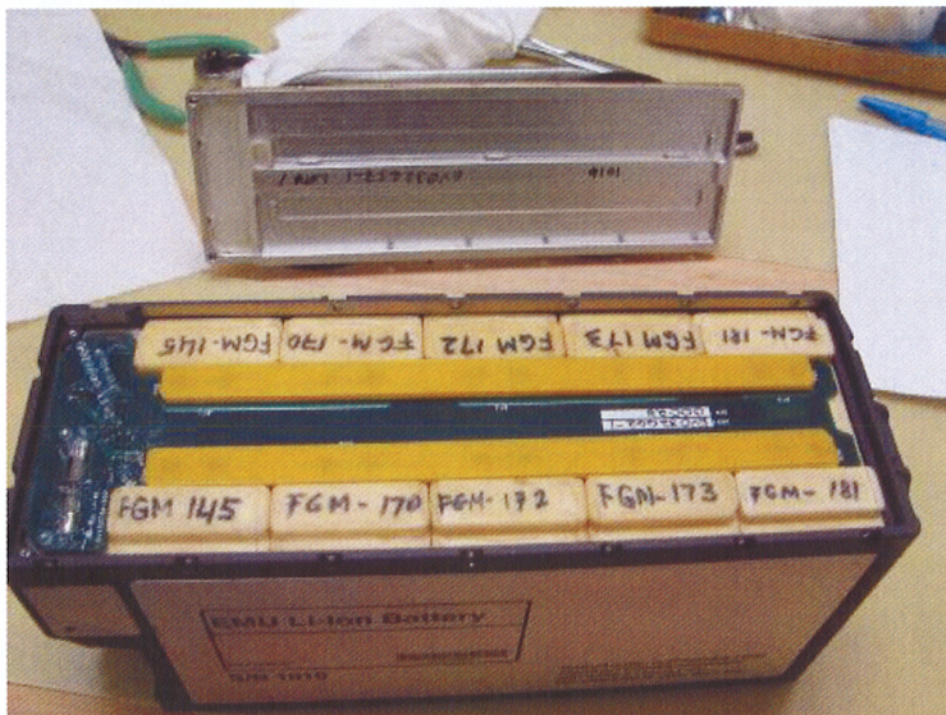


Figure 2. Five LIB Cell Modules inside LIB housing. Edges of lid mate with shoulders of LIB Cell Module.

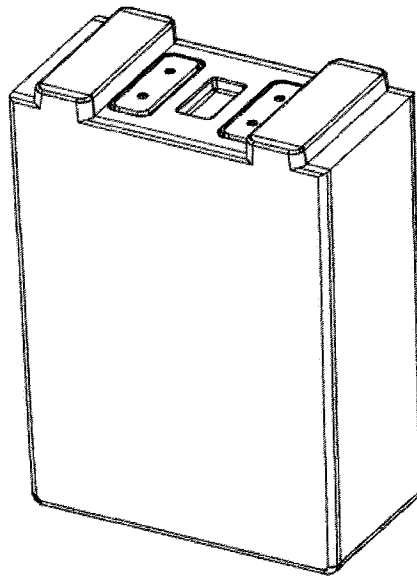


Figure 3. Oblique view of LIB Cell Module

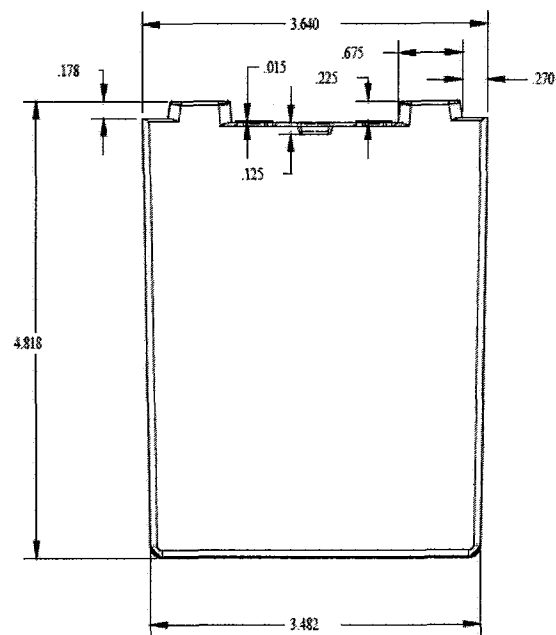


Figure 4. Side View Dimensions (inches) of LIB Cell Module

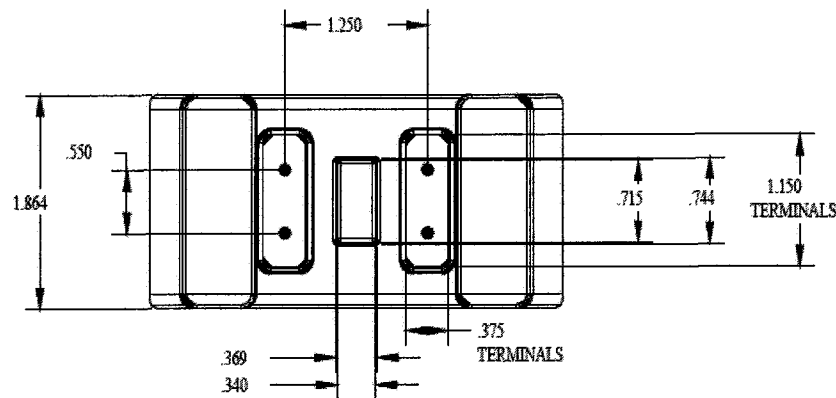


Figure 5. Top View Dimensions (inches) of LIB Cell Module

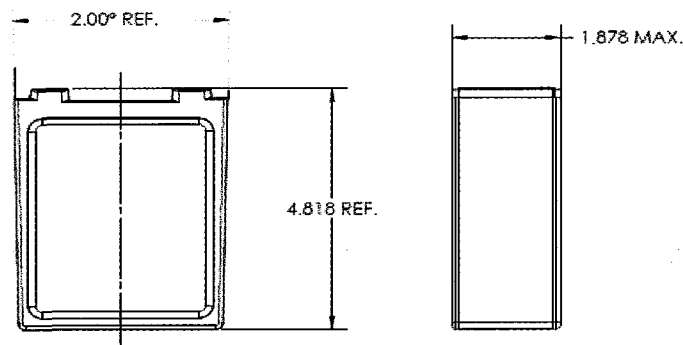


Figure 6. Side and Edge Dimensions (in) of LIB Cell Module

3.4 Refurbishment

At the end of its service life, the LLB shall be refurbished to enable it to once again meet its service life by only replacing its Cell Module or Cell Brick and its terminal fasteners.

3.5 Reliability

The requirement of the LIB is to be two-failure tolerant to catastrophic failures and single-failure tolerant to critical failures. However, due to its simplicity of design and to the simplicity of the design of the PLSS interface, an exception is granted for the occurrence of a low impedance (short) failure as specified in the Critical Items List for the LIB. Therefore, the Cell Module shall be capable of meeting the capacity and service life requirements herein after a single high impedance (open) failure.

4. Electrical Interfaces

4.1 Electrical Connection

The Cell Module/Cell Brick Assemblies shall be electrically connected to a redesigned version of the Interconnecting Board (P/N EV132736). The Cell Module/Cell Brick designer will have a say into the redesign of the board. Currently, the physical connection is made by contacting the pads surrounding plated-through holes in the circuit board to the terminals of the Cell Module. To ensure adequate contact, the Cell Module metallic surface area available for electrical contact shall be per Figure 5.

4.2 Electrical Power Characteristics

The LLB shall operate in three Modes: Charge, Use in the EMU, and test in the LIB Charger. The test conditions are set to simulate normal use conditions. The LLB shall accept charge at a constant-current rate of up to 6.5 amperes with a constant-voltage taper charge to a maximum of 4.1 volts per cell module with a 1A taper termination limit when charged by the LIB Charger. When in the EMU, the Shuttle Air Lock Power Supply (ALPS) Charger charges the LLB at 1.55A constant current to a termination voltage of 21.8V. Charge termination at a lower voltage is possible with a manual interruption of charge by the crew upon direction by ground controllers monitoring battery voltage telemetry data. Note that this manual termination is ensured within a maximum of 3 hours after ground control notification. The LLB shall deliver power to the PLSS, under normal operation, at a maximum current of 3.8 amperes at voltages varying from a full-charge voltage of 20.25 ± 0.25 volts to a full-discharge voltage of 16.0 volts. The LLB shall deliver turn-on transient current pulses in excess of the average, and up to a nominal 9 amperes for 5 seconds (see current interruption characteristics). The total storage capacity of the LLB, available for delivery to the EMU-PLSS on discharge at the above currents and within the above voltage range shall not be less than 26.6 amp-hours throughout its 5 year service life. The LLB provides current limit protection on the negative terminals for currents delivered to, or taken from, the LLB. The protection characteristic depends on the thermal and pressure environment of the LLB enclosure, but is a nominal terrestrial “hold” of 15 Amperes and a guaranteed terrestrial trip of 20.25 Amperes (within 1 hour). The circuit is equipped with a redundant fuse holder (F2 in the circuit diagram) into which a back-up fuse may be inserted to cover contingencies where the primary fuse is “blown”. This redundant fuse holder is normally covered by a thin removable (single use) adhesive cover plate. A description of the electrical schematic of the LLB is in the IDD for the LIB (EV307705).

4.3 Continuity

The Cell Module and Cell Brick Assemblies shall have a total DC impedance of less than 15 m Ω and 75 m Ω , respectively, throughout its service life.

4.4 Isolation Resistance

The Cell Module/Cell Brick shall not prevent the LLB from having an insulation resistance of $>5\text{M}\Omega$ between the J1 or J2 terminals and the LLB chassis.

5 Thermal Interfaces

5.1 Heat Generation

During charge or discharge at 3.8 amperes the total rate of heat generation in the LLB shall be less than 10 watts.

5.2 Operating Temperature

The LLB shall be designed to remain within its specifications of capacity, impedance and voltage when operating in the temperature range of 10°C to 43°C (50°F to 109°F) throughout its service life. Charging will nominal occur in the cabin temperature range of 10°C to 32°C (50°F to 86°F).

6 Environment Interfaces

The Cell Module shall allow the LLB to operate within the limits of the environment specified in the LLB End Item Specification (EIS), JSC29928.

7 Abbreviations and Acronyms

°C	Degrees Celsius
°F	Degrees Fahrenheit
A	Ampere
AC	Alternating Current
ADC	Analog-to-Digital Converter
Ah	Ampere-Hour
ANSI	American National Standard Institute
ALPS	Air Lock Power Supply
ASCII	American Standard Code for Information Interchange
BCA	Battery Charger Assembly
BIOS	Basic Input/Output System
CDR	Critical Design Review
COTS	Commercial off-the-Shelf
CR	Change Request
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
DAC	Digital-to-Analog Converter
DC	Direct Current
DR	Discrepancy Report
EEE	Electrical, Electronic and Electromechanical
EIS	End Item Specification
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EVA	Extravehicular Activity
FCE	Flight Certified Equipment
GCAR	Safety and Mission Assurance Certification Approval Request
GFE	Government Furnished Equipment
gm	Gram
ICD	Interface Control Document
in	Inch
ISO	International Organization for Standardization
ISS	International Space Station
ITMG	Meteorite protection garment
J	Joule
JSC	Johnson Space Center
K	Kelvin
kg	Kilogram
KSC	Kennedy Space Center
L	Liter
LED	Light Emitting Diode
LIB	Lithium Ion Battery
LSB	Least Significant Bit

m ²	Meters squared
mΩ	Milliohm
MIL-STD	Military Standard
min	Minute
mm	Millimeter
ms	Millisecond
MSFC	Marshall Space Flight Center
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
OCV	Open Circuit Voltage
OS	Operating System
PC	Personal Computer
PCB	Printed Circuit Board
PDR	Preliminary Design Review
PLSS	Primary Life Support Subsystem
PRACA	Problem Reporting and Corrective Action
PVG	Pack Voltage Good (logic signal)
QMS	Quality Management System
RAM	Random Access Memory
RDMS	Risk Data Management System
S&MA	Safety and Mission Assurance
SDP	Software Development Plan
sec	second
SEE	Single Event Effects
SR&QA	Safety, Reliability, and Quality Assurance
SRS	Software Requirement Specification
SS	Space Shuttle
SSP	Space Station Program
TBD	To Be Determined
USB	Universal Serial Bus
V	Volt
VC	Visibly Clean
VDC	Direct Current Voltage
W	Watt
WDT	Watchdog Timer